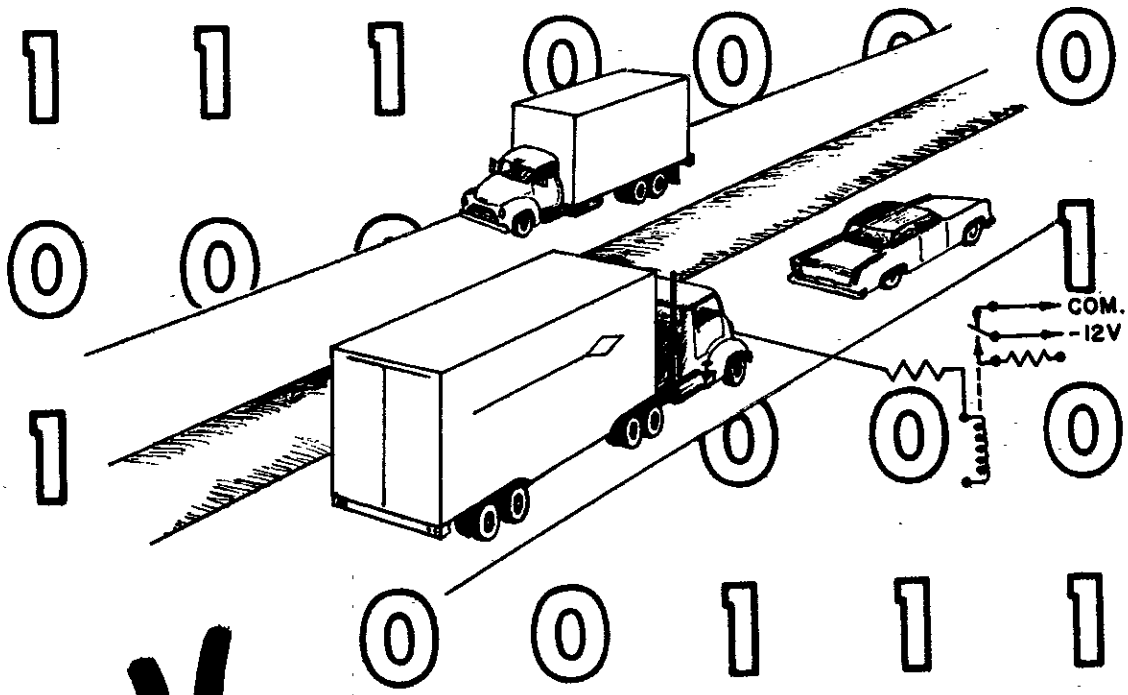
A REPORT ON THE DEVELOPMENT OF A TRUCK CLASSIFICATION COUNTER



65-16

MATERIALS AND RESEARCH DEPARTMENT

RESEARCH REPORT

NO. M & R 263058

Prepared in Cooperation with The U.S. Department of Commerce, Bureau of Public Roads October, 1965

This is a report on the project entitled "Special Classified Truck Counters". The work was done under the 1963-64 and 1964-65 Work Program HPR 1 (2) C-1-3 in cooperation with the U. S. Department of Commerce, Bureau of Public Roads.

State of California
Transportation Agency
Department of Public Works
Division of Highways
Materials and Research Department

October 1965

Lab. W. O. No. 263058

Hdqtrs. W. O. No. 300109

Mr. George A. Hill
Assistant State Highway Engineer
Planning Department
California Division of Highways
Sacramento, California

Dear Sir:

Submitted for your consideration is:

A REPORT ON THE

DEVELOPMENT OF A TRUCK CLASSIFICATION COUNTER

Study made by . . . . . Structural Materials Section
Under general direction of . . . . . E. F. Nordlin
Under general supervision of . J. E. Barton and R. L. Donner
Report prepared by . . . . . R. L. Donner and M. E. Wilson

Very truly yours,

JOHN L. BEATON
Materials and Research Engineer

RLD/MEW:mw
cc: LRGillis
FEBaxter
JEWilson
GFChester

I. INTRODUCTION

In accordance with Mr. F. E. Baxter's memorandum to Mr. L. R. Gillis dated May 1, 1963, the Materials and Research Department has developed and constructed two sets of two-lane vehicle classification counters. The design of these counters was based on Employee Suggestion No. 32829 developed by Mr. G. F. Chester, Jr., of District 02. Each counter set consists of two single lane counters capable of totalizing the number of vehicles in each of the two, three, four, five and more, axle categories.

It is understood that if, after extensive field testing, this counter is proven as reliable as the initial test indicates, it will be used to replace the current statewide manual truck count. As pointed out in Mr. Baxter's memorandum of May 1, 1963, for technical and physical reasons no attempt was made in this study to develop a counting device which would separate dual-tired axles from single-tired axles. Because of the present limitations of expense, portability and power consumption, methods of recording hourly or daily data and methods of separating two axle autos and two axle trucks were not pursued. If desired as a research project in the future, it is felt that methods can be developed to supplement and modify this counting system so that this added traffic data could also be automatically recorded.

II. SUMMARY AND RECOMMENDATIONS

Initial evaluation of the original truck classification counter suggested by Mr. G. F. Chester showed many desirable features which have been incorporated into the counters herein described. One critical drawback realized by the Headquarters Traffic Department, Mr. Chester and this department was the large size and weight of the system proposed. The original design incorporated a vehicle detector, counting equipment, and a 6 volt storage battery in a Streeter-Amet R-C Counter case plus three auxiliary R-C counters to record the separate axle classes of vehicles. Although the recording feature is desirable, it was felt that recording could not be warranted because of the excessive size and weight. The selected criteria of the design was light weight and minimum size. Because of these limitations, the resulting counter was developed around transistor counting circuits, electro-mechanical counters, and dry type batteries. Two basic circuits were developed. The first followed closely the functions of Mr. Chester's design incorporating a time delay relay in the three axle circuit to prevent false termination of the circuit during the presence of a logging trailer. The second design was limited to a minimum delay of the pulse output to all circuits. The time delay circuit was not incorporated in the second design because of its limited use in only a few districts.

An attempt was made to incorporate standard or commonly used components in all parts of the circuits. This is demonstrated by the use of the R.C.A. loop detector which is in common use in traffic signal installations, the NEDA-1 battery which is the state standard for traffic warning flashers, the Streeter-Amet air switch used in the Fisher Porter Counter and the Fisher Porter carrying case. The counting circuit, although unique to this counter, was constructed from standard digital circuits on plug-in cards to facilitate replacement and trouble shooting.

It is our opinion that this method of vehicle counting and classification can obtain information to the accuracy and reliability currently accepted by the traffic counting field. If further field tests prove as successful as initial indications, this method could become a valuable tool for traffic studies.

The information obtained from this counter will fulfill many of the current traffic study requirements, but there are also many limitations on this device such as the following:

a. There is no provision for time density information in the machine as it is currently designed.

b. Dual-tires cannot be detected.

c. Two axle trucks cannot be separated from two axle cars.

d. Three axle car-trailer combinations cannot be separated from three axle trucks.

e. The axle load cannot be determined; therefore a full truck is counted the same as an empty one.

f. Without the time delay relay some tractor-trailer combinations will be recorded as two vehicles when a long tongue is employed as in logging trucks and some gravel trucks.

g. With the time delay it could be possible at very low speeds to detect two closely following vehicles as one when the first has three axles.

Although the list of limitations is numerous and probably incomplete, many of these restrictions could be eliminated through additional circuitry and improved design which could be considered in a future research project.

d. Three axle car-trailer combinations cannot be separated from three axle trucks.

e. The axle load cannot be determined; therefore a full truck is counted the same as an empty one.

f. Without the time delay relay some tractor-trailer combinations will be recorded as two vehicles when a long tongue is employed as in logging trucks and some gravel trucks.

g. With the time delay it could be possible at very low speeds to detect two closely following vehicles as one when the first has three axles.

Although the list of limitations is numerous and probably incomplete, many of these restrictions could be eliminated through additional circuitry and improved design which could be considered in a future research project.

2. Air Switch.

The air switch axle detector consists simply of the rubber hose and pneumatic switch of the type used in the Streeter-Amet and Fisher Porter counters. The air switch, Streeter-Amet Part No. 9101406 has a flexible diaphragm operating a spring loaded contact against a stationary contact. The air pulse from the road hose moves the diaphragm and contact against the stationary contact giving one contact closure per axle. The output of this contact closure is applied to the counter logic circuit. The air switch may be seen in Exhibits 3, 4, and 5.

3. Power Supply.

The power source consists of seven NEDA No. 1 six volt batteries shown in Exhibits 6 and 7. Four of these batteries are placed in series to produce 24 volts to operate the loop detector. Three batteries are placed in series with taps to supply the +6V, -6V, and -12V needed for the counter logic circuit. The two voltage supplies were separated because of the unbalanced power requirements of the loop detector and logic circuits and to eliminate any interaction between the two units. The power is switched through a four pole single throw rotary switch.

4. Relay and Reset Circuit.

This circuit is shown in Exhibit 7 and consists of three HGS 1006 relays and associated components. Pictorial views of the counter incorporating the "time delay" feature are shown in Exhibits 8 and 9. When a vehicle enters the loop, the output relay in the Ve-Det is de-energized, closing pin 6 to 5, thus energizing the count relay through a 1K resistor; this closes pin 3 to pin 1 and energizes the power relay through a 1K resistor opening pin 5 to 3 and closing pin 3 to 1. The opening of pin 5 produces a positive pulse at the junction of the 47K resistor which resets the transistor counting circuits. Since the HGS 1006 is a make before break relay, power is applied to pin A of the printed circuit boards of the counter logic circuit before the reset pulse is produced.

When the vehicle leaves the loop, the output relay is energized connecting pin 6 to pin 7 removing the power from the counting relay and applying -12 volts to the counter common circuit. This voltage energizes the axle counter selected by the counter logic circuit designating the appropriate axle group. When the count relay is de-energized, the power is removed from the power relay but this relay is delayed from dropping out by the 16 uf capacitor and 1.5K resistor across it.

After this short delay, which allows time for the axle counter to energize, the power relay drops out disconnecting pin 3 and pin 1 and removing the power from the counter logic circuit. The counter is now in the idle position with only the Ve-Det energized to detect the next vehicle.

5. Counter Logic Circuit.

The counter logic circuit is constructed from five printed circuit plug-in logic boards. The interconnection for these boards is shown in Exhibit 10. There are four different boards used. These circuits are standard circuit boards manufactured by Engineered Electronics Co., and are listed and described below:

a. One one-shot multivibrator G-306 which takes the pulse from the axle detecting air switch and produces a uniform amplitude and duration pulse for the counting circuit. The one-shot circuit is shown in Exhibit 11.

b. Two Dual Gated Flip-Flops G-301, shown in Exhibit 12, are wired for asynchronous trigger operation. This forms the counter circuit FF1A, FF1B, FF2A, and FF2B. The counter circuit takes each axle pulse from the one-shot multivibrator, accumulates and presents to the logic circuit an output which indicates the number of axles which have triggered the air switch. Exhibit 13 shows the operational sequence for the flip-flop circuits.

c. One Universal Logic G-701 wired as four three-input AND circuits is shown in Exhibit 14. The logic circuit takes the coded information from the counter circuit and translates it to a four line output indicating one of four axle groups 2, 3, 4, or 5 and more. The counter logic circuit is only capable of counting up to seven axles. An eighth axle would reset the circuit to one and start counting successive axles from there.

d. One Relay Driver G-502, shown in Exhibit 15, consists of four driving circuits each connected to an AND logic circuit and each activated when a particular sum of axles is reached. Although the relay drivers are actuated in sequence, the axle counters do not indicate until the vehicle leaves the loop and the count relay de-energizes. The driver circuit which is active at the time the count relay applies -12 volts to the counter common is the axle group which records an indication of one vehicle.

These five circuit boards are interwired as shown in Exhibit 10. The letter in each block identifies the pins on the 22 pin socket. Each socket has polarizing pins which will allow only the proper board in the correct direction to be used in each socket.

6. Axle Counters.

Four Sodeco TCeB5E electro-mechanical counters are incorporated in the circuit. Each counter indicates one of four axle groups 2, 3, 4, or (5, 6, 7) axles. The counters are capable of counting 10 counts per second when operating on 12 volts. A -12V is supplied to the counter common circuit when the count relay is de-energized and the ground completion of the circuit is made through the relay driver for the particular axle group required.

Exhibit 7 shows the complete relay and reset circuit for the counter incorporating the "time delay" feature. In the counter which did not have this feature the log and count relays were eliminated and point "A" on the schematic was connected directly to pin 7 of the Ve-Det Jones plug and the counter common was connected to pin 5 of the Jones plug.

IV. Field Installation

The equipment required for each lane at a truck classification counting station is simply an inductive loop installation either surface or in a slot, a counter hose and the truck classification counter. The loop is centered in the traveled lane with the recommended 6' x 6' configuration. A counter air hose is secured across the lane in the trailing or third portion of the loop as shown in Exhibit 16. A hose restriction is placed in the hose so that only the air pulse from the lane desired reaches the air switch. Twenty to thirty feet of hose should be coiled near the counter to act as a damper. This will minimize contact bouncing of the air switch which would result in over counting.

The points on the air switch will probably be set between .015 and .022 of an inch. This setting varies because of different lengths of hose at different sites. Uniformity can be obtained by using the same lengths of hose at all installations. The adjustment of the air switch is the most critical one to be made. Observe counting on trucks and medium size cars and correct for over and undercounting. It may be necessary to miss some small light cars in order to adjust for optimum counting of trucks.

The instructions by the manufacturer of the vehicle detector are easily understood and no difficulties should arise if the instructions are carefully followed.

The operational life of these counters using fresh NEDA No. 1 batteries should be approximately 2 weeks. Tests in 50° to 70° F weather with the counter on 8 days then off 2 days, then on 7 days, show that the counter will stop counting when the Ve-Det 24 volts drops below 18 volts or the -6 volt supply goes below -5 volts.

For further information on installation and trouble shooting these units, consult the "Instructions for Installing Classifying Vehicle Counter" issued by California Division of Highways, Headquarters Traffic Department.

V. BIBLIOGRAPHY

Chester, Gordon, Jr., "A Device to Count and Record the Number of Axles on Each Vehicle", September 7, 1962.

Engineered Electronics Co., "Digital Circuit Modules Catalog G-53", May 1963.

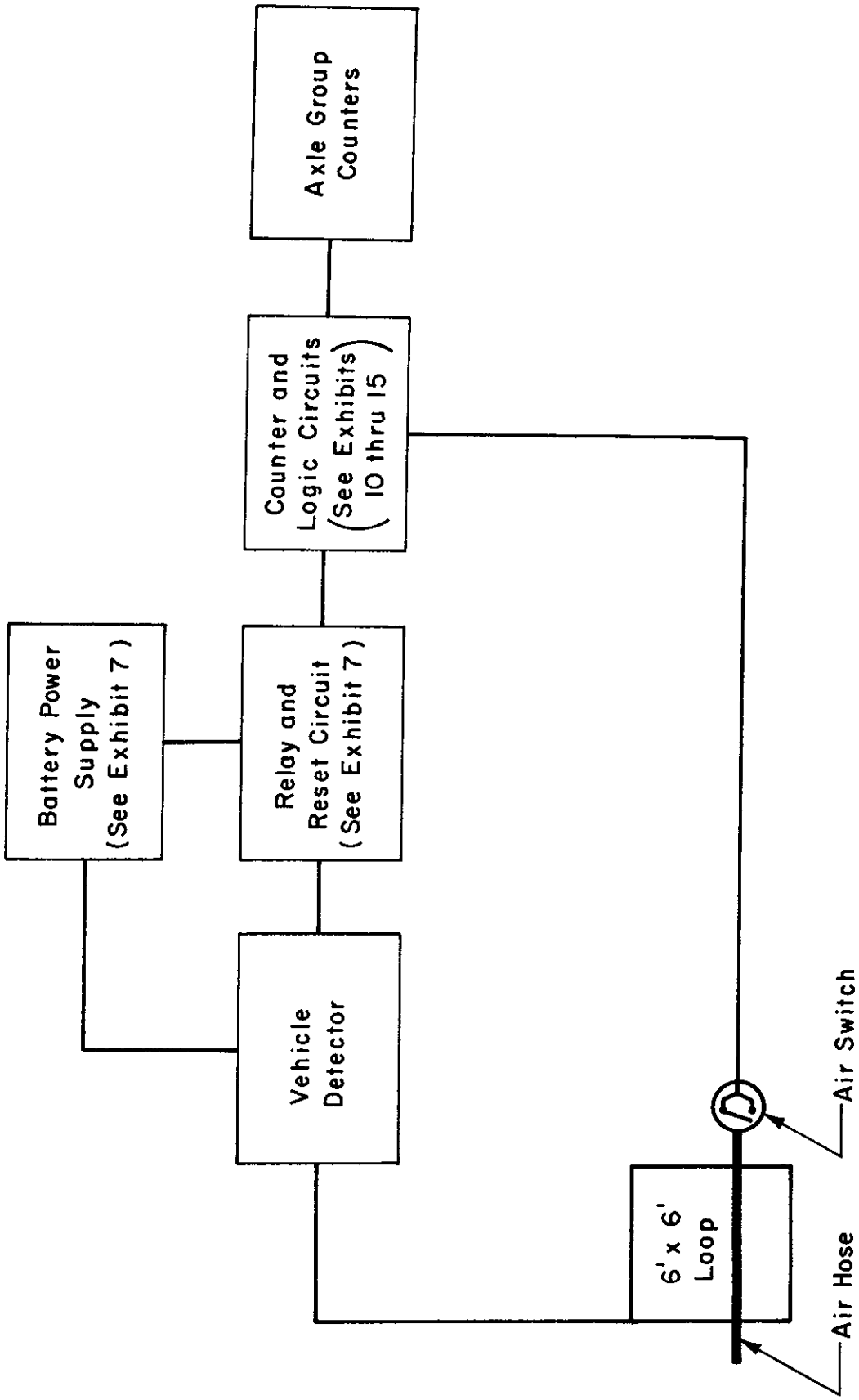
Packard Bell Computer, "Digital Module Application Manual PBC 4118", May 15, 1962.

RCA Industrial & Automation Products, "Electronic Vehicle Detection", 1963.

Traffic Department, California Division of Highways, "Instructions for Installing Classifying Vehicle Counter", to be issued in late 1965.

VI. APPENDIX

EXHIBIT 1



Circuit Block Diagram

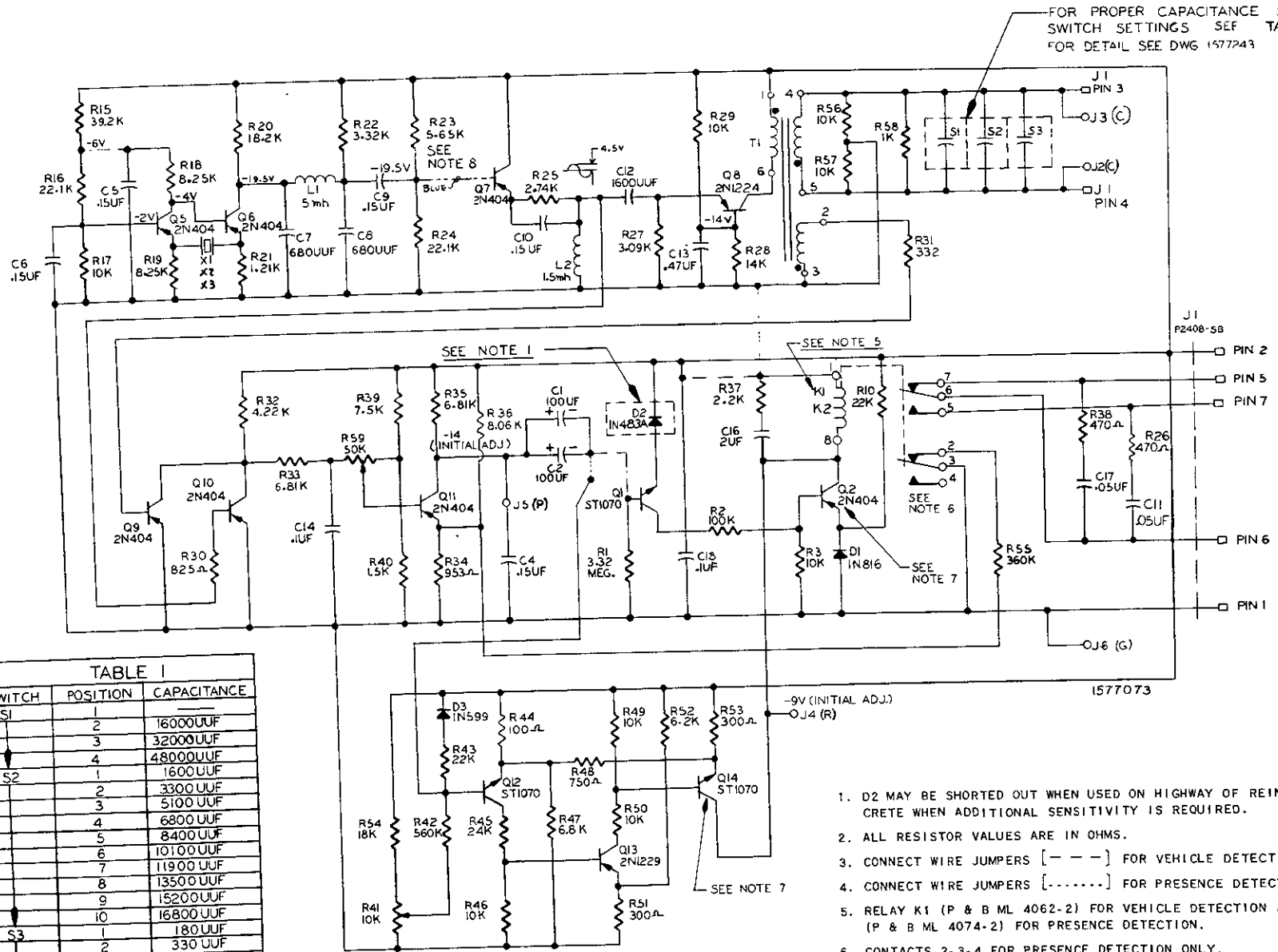
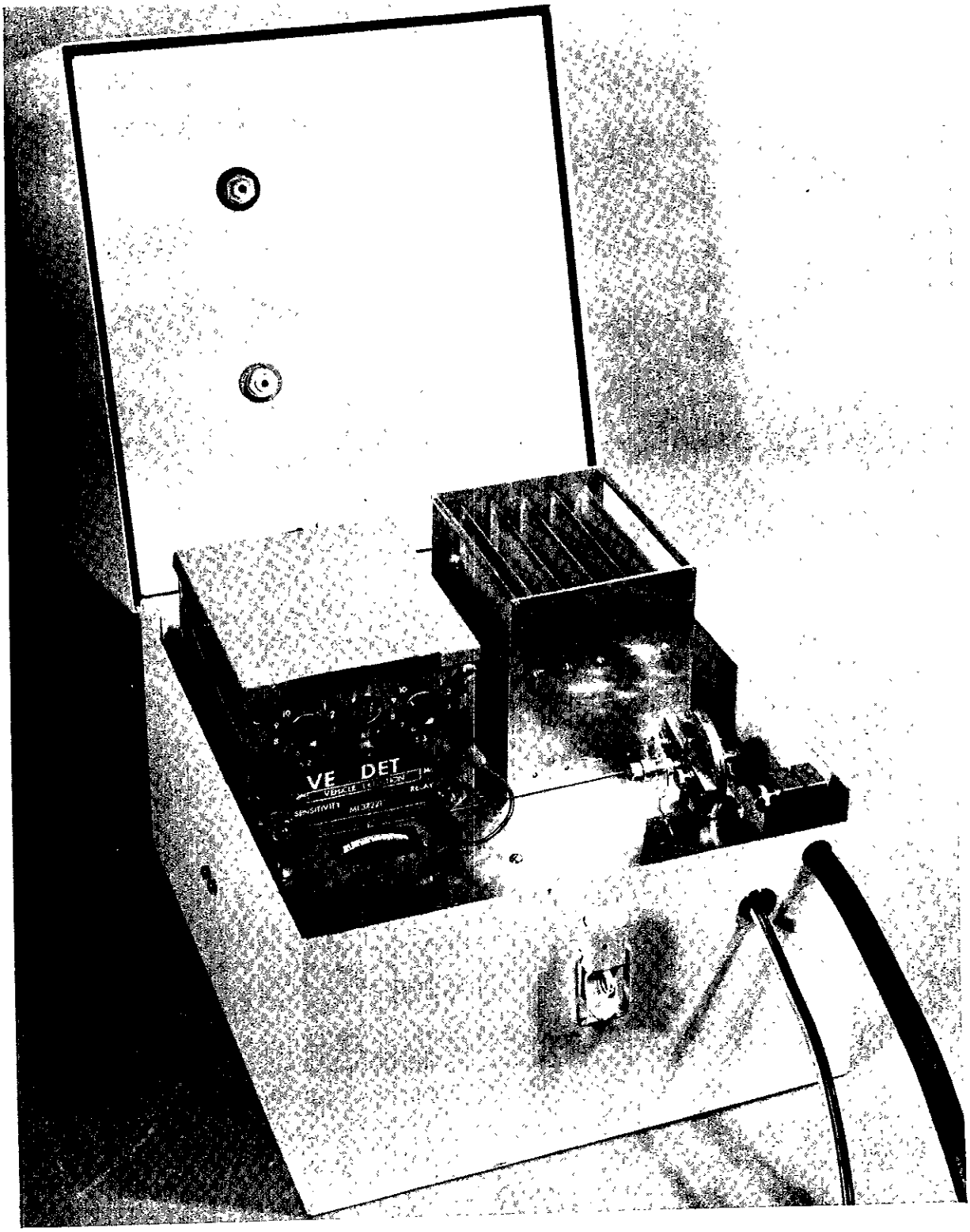


TABLE 1		
SWITCH	POSITION	CAPACITANCE
S1	1	—
	2	16000 UUF
	3	32000 UUF
	4	48000 UUF
S2	1	1600 UUF
	2	3300 UUF
	3	5100 UUF
	4	6800 UUF
	5	8400 UUF
	6	10100 UUF
	7	11900 UUF
	8	13500 UUF
	9	15200 UUF
	10	16800 UUF
S3	1	180 UUF
	2	330 UUF
	3	510 UUF
	4	680 UUF
	5	860 UUF
	6	1010 UUF
	7	1190 UUF
	8	1370 UUF
	9	1520 UUF
	10	1700 UUF

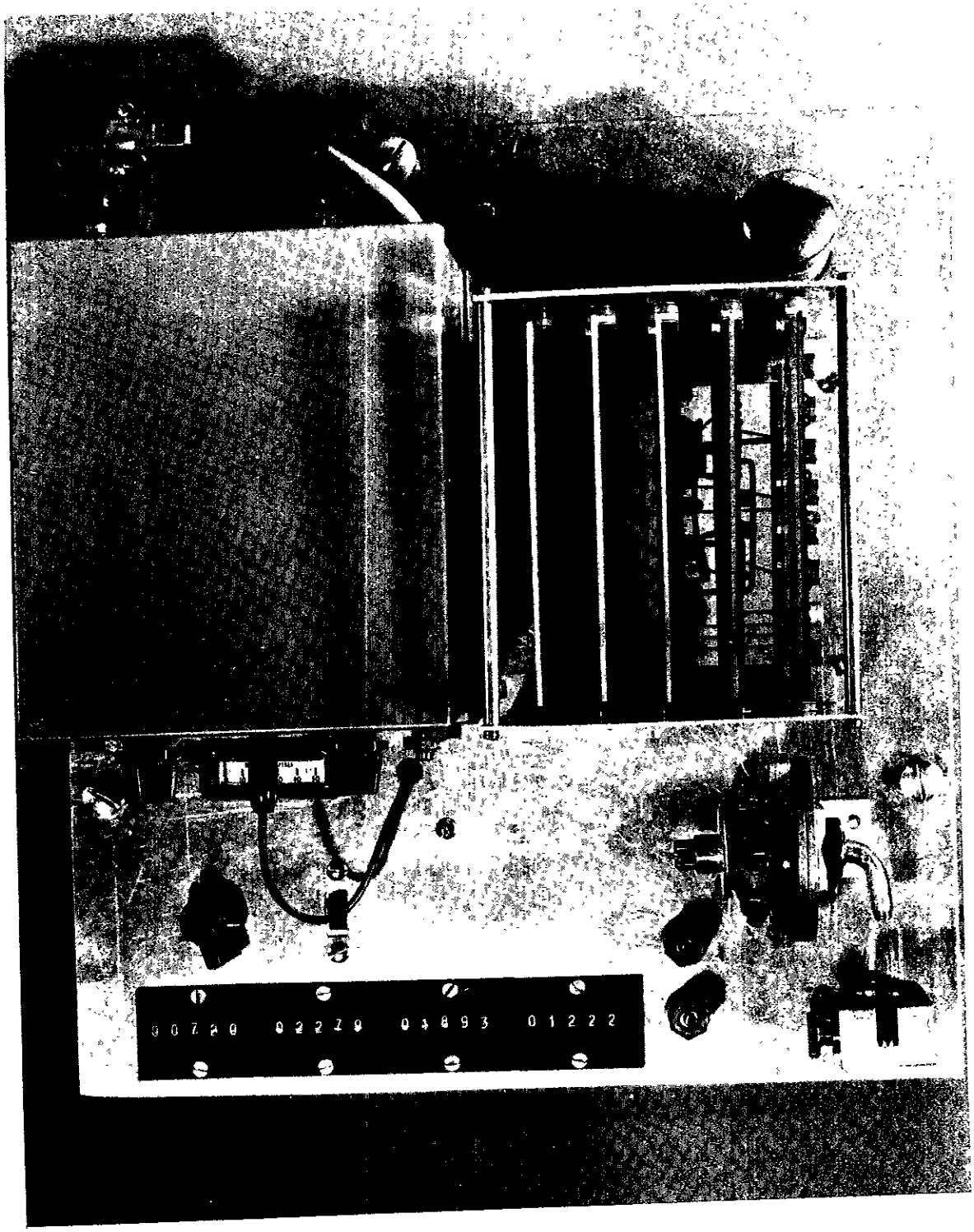
1. D2 MAY BE SHORTED OUT WHEN USED ON HIGHWAY OF REINFORCED CONCRETE WHEN ADDITIONAL SENSITIVITY IS REQUIRED.
2. ALL RESISTOR VALUES ARE IN OHMS.
3. CONNECT WIRE JUMPERS [— — —] FOR VEHICLE DETECTION.
4. CONNECT WIRE JUMPERS [-------] FOR PRESENCE DETECTION.
5. RELAY K1 (P & B ML 4062-2) FOR VEHICLE DETECTION AND RELAY K2 (P & B ML 4074-2) FOR PRESENCE DETECTION.
6. CONTACTS 2-3-4 FOR PRESENCE DETECTION ONLY.
7. TRANSISTORS Q12, Q13 & Q14 ARE NOT FURNISHED FOR VEHICLE DETECTION. TRANSISTORS Q1 & Q2 ARE NOT FURNISHED FOR PRESENCE DETECTION.
8. DISCONNECT BLUE WIRE JUMPER [——— — ———] FOR UNITS TO BE DRIVEN BY THE OSCILLATOR IN ANOTHER UNIT.

Sensor Unit Schematic Diagram

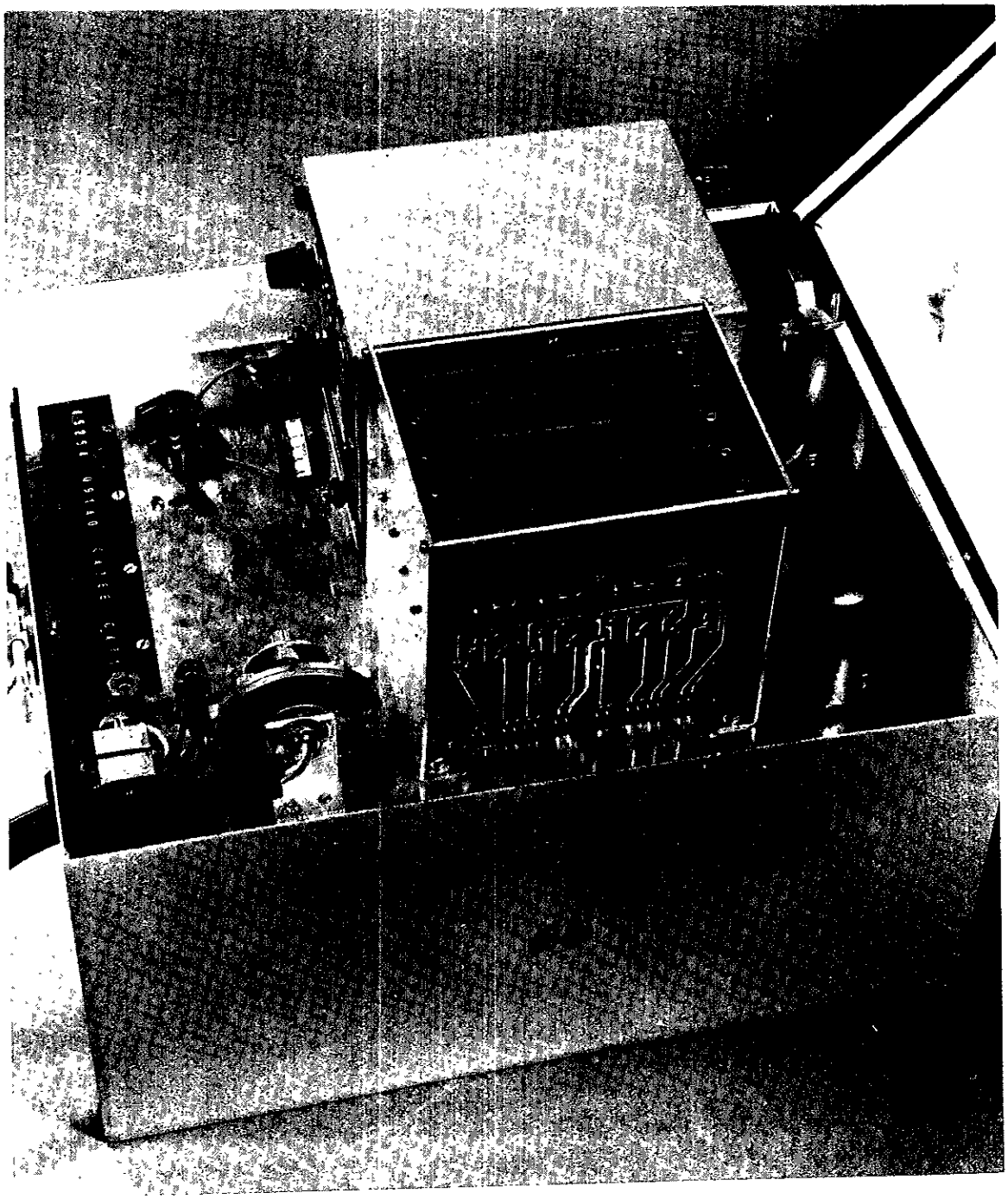
EXHIBIT 2



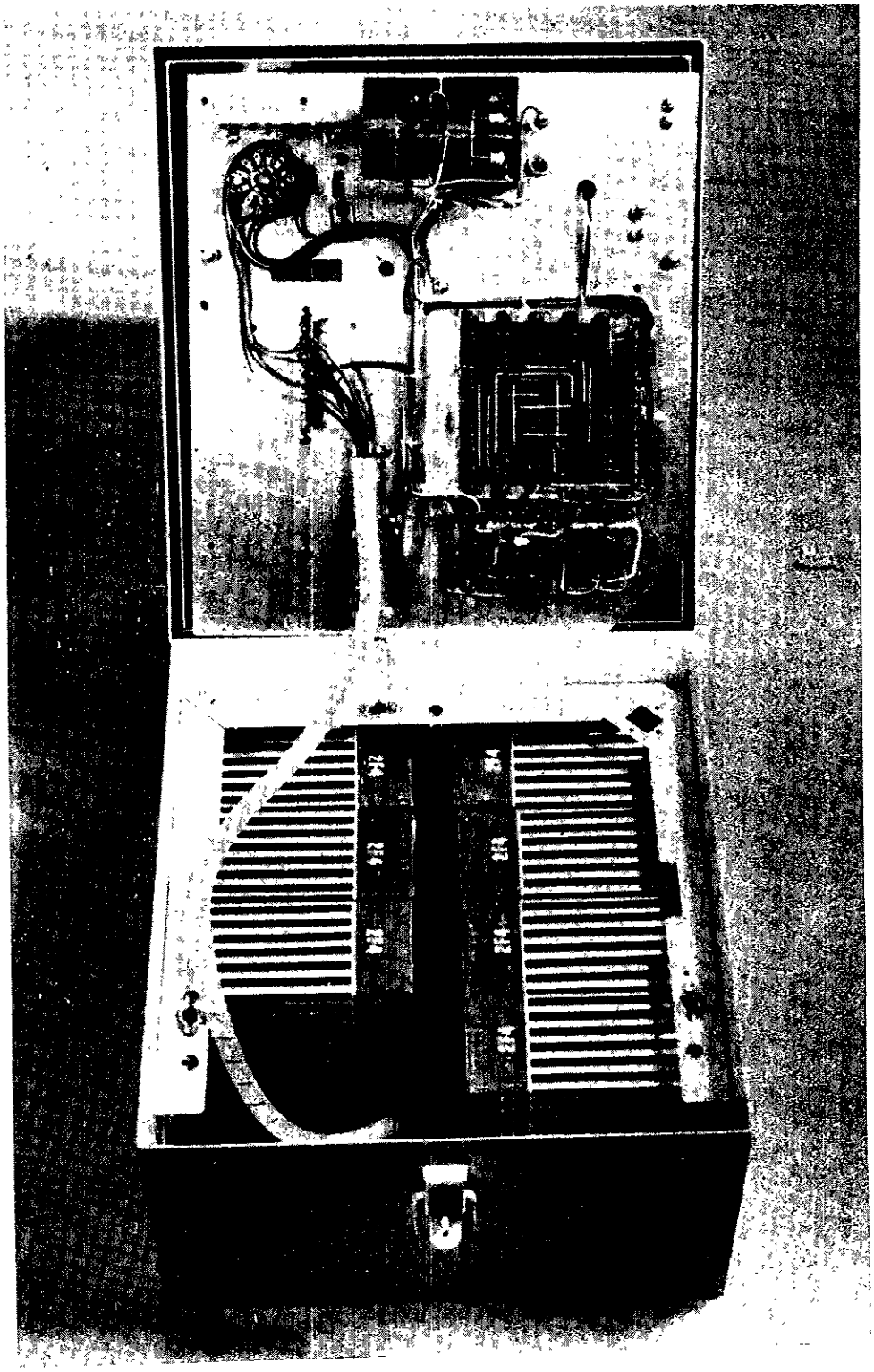
Counter in Case - Top View



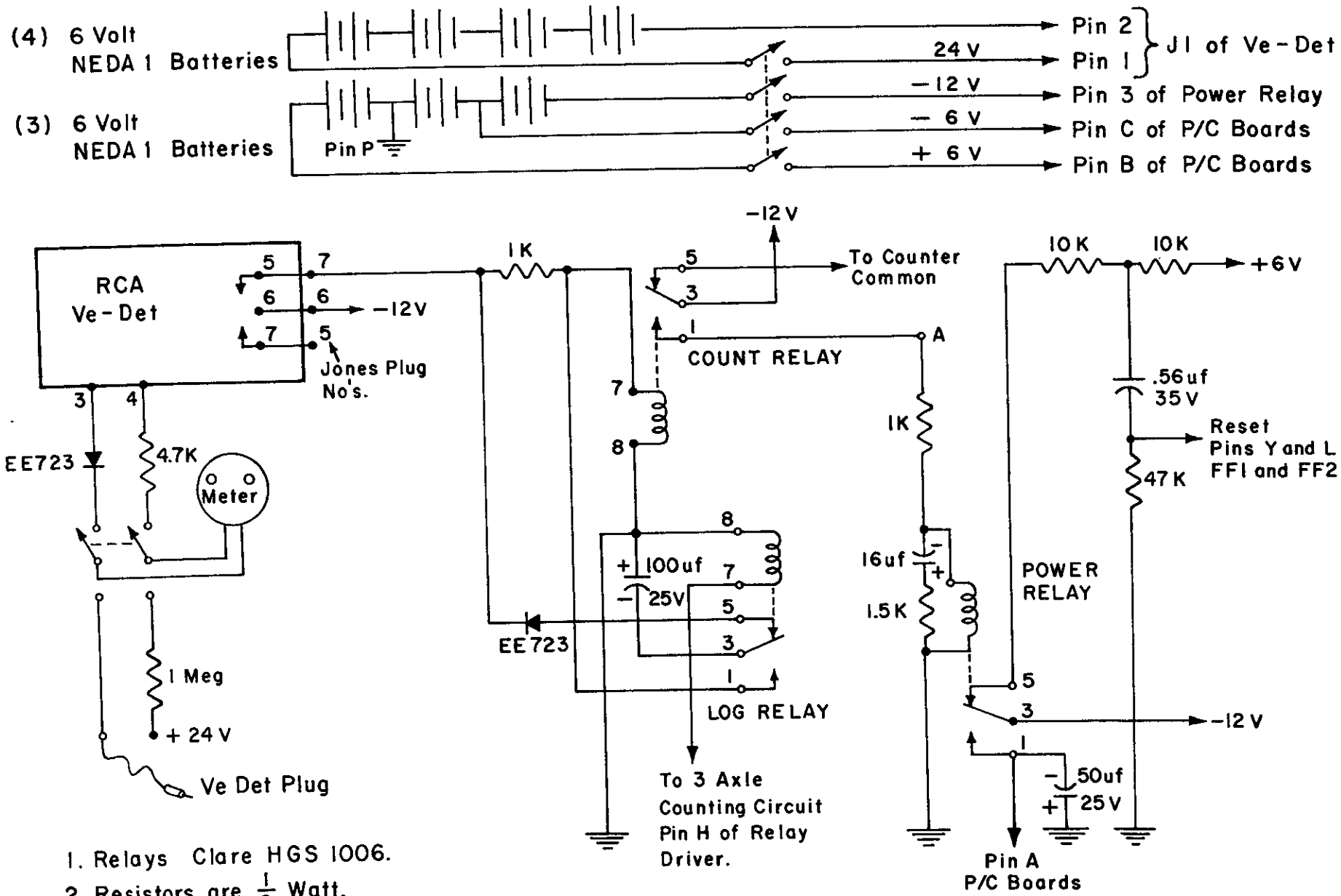
Counter Chassis - Top View



Counter in Case - Side View



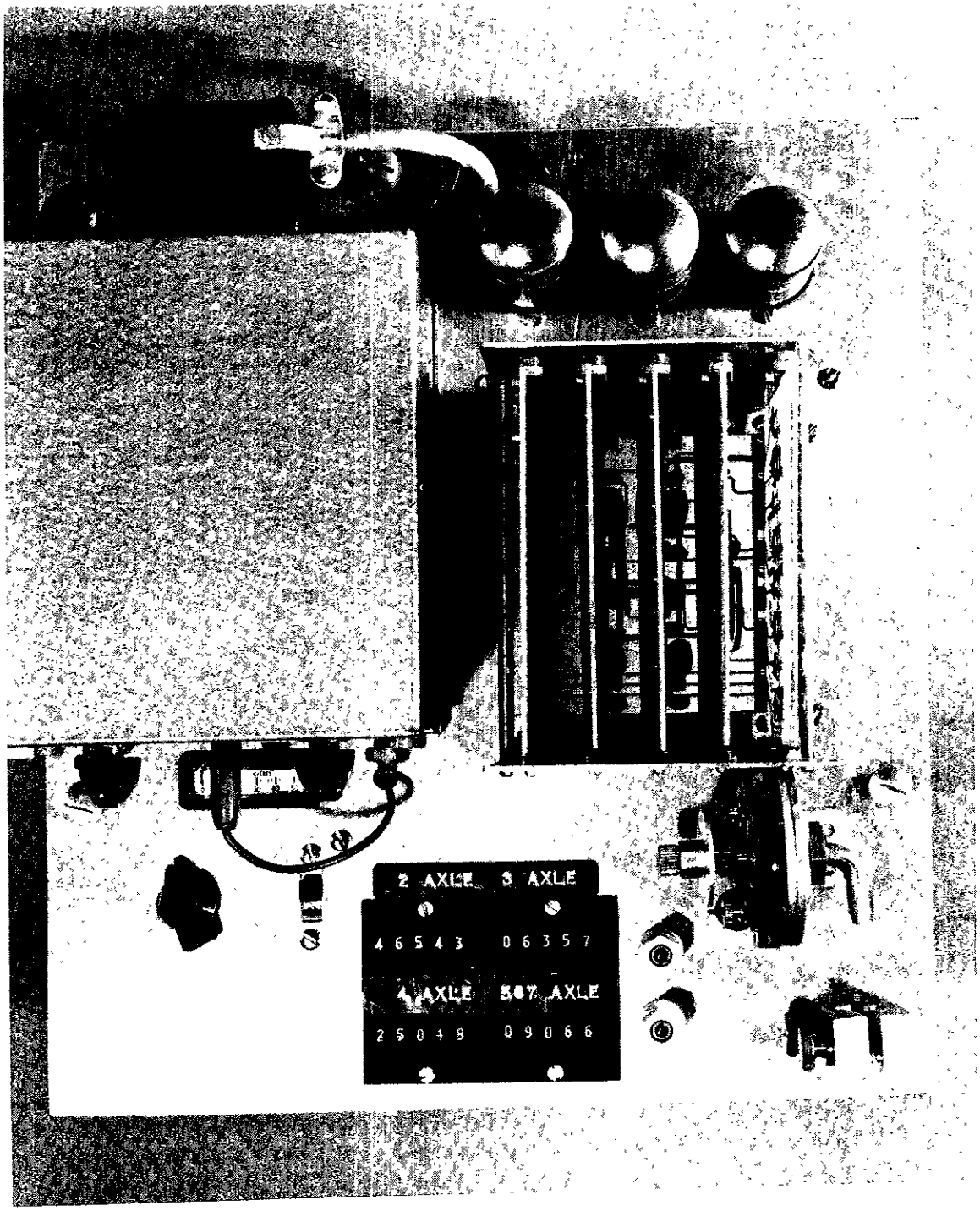
Counter in Case with Batteries - Bottom View



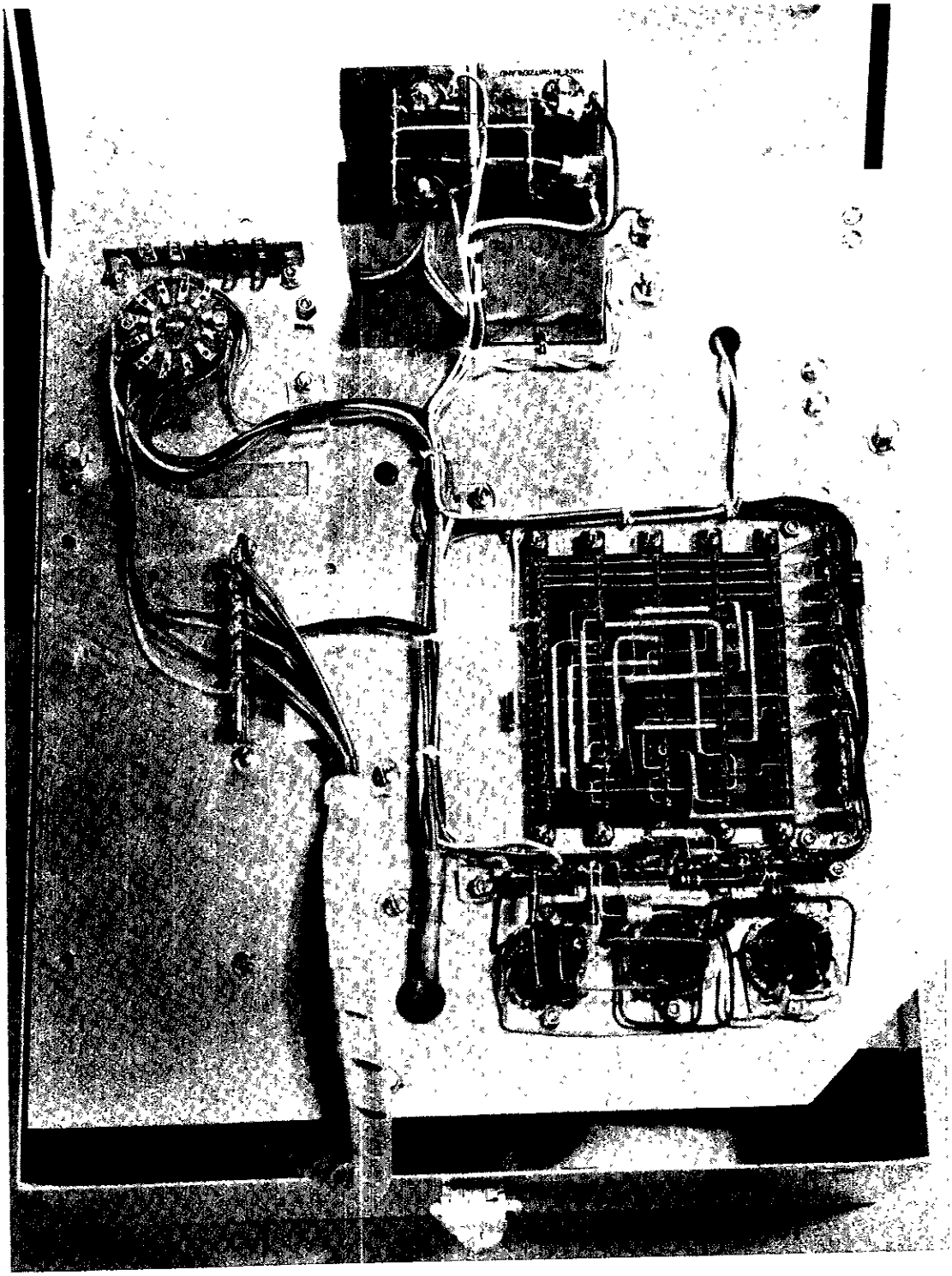
1. Relays Clare HGS 1006.
2. Resistors are $\frac{1}{2}$ Watt.
3. Relays shown with power on - No vehicle in loop.

Relay and Reset Circuit Diagram

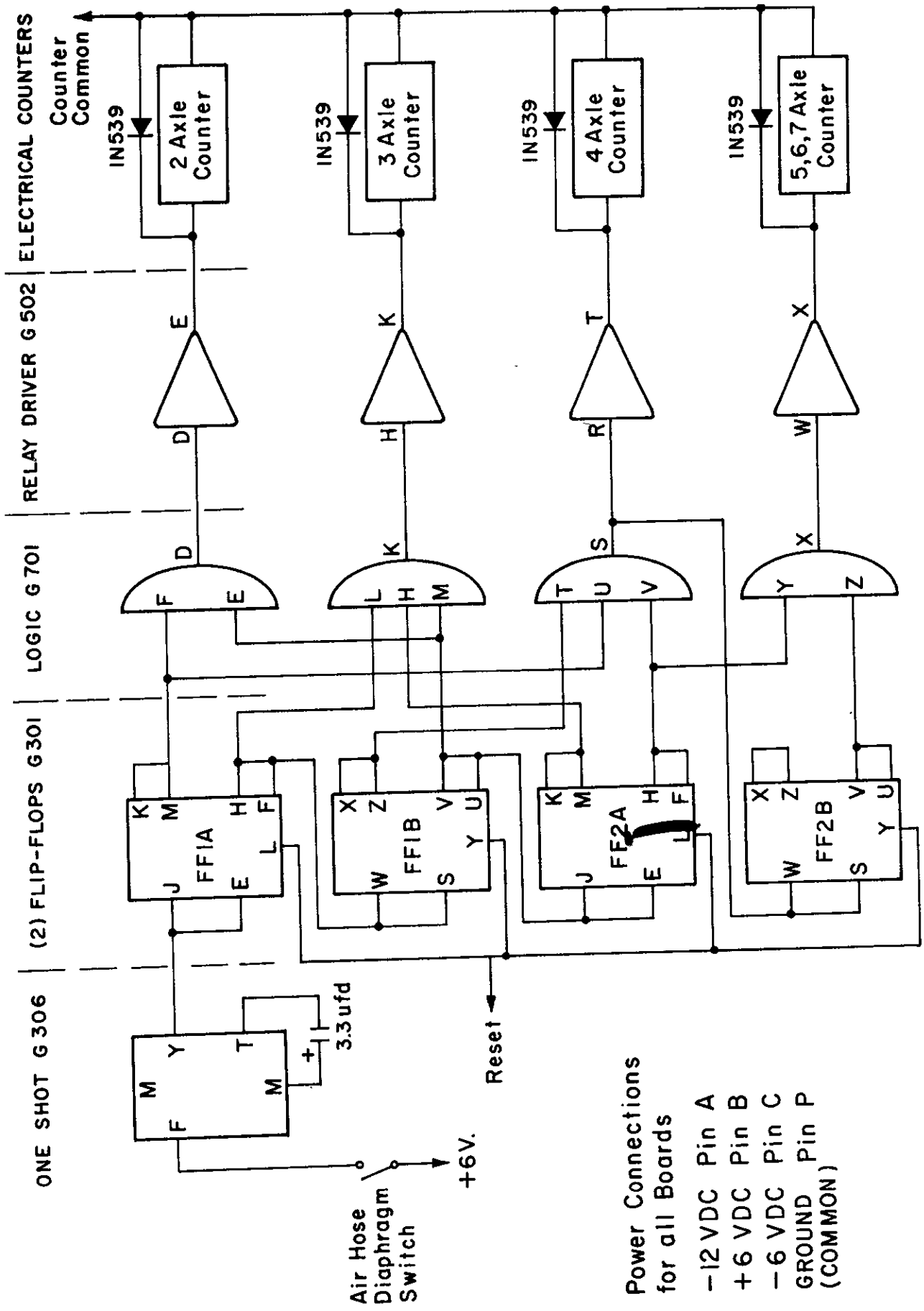
EXHIBIT 7



Counter Chassis "Time Delay Unit" - Top View

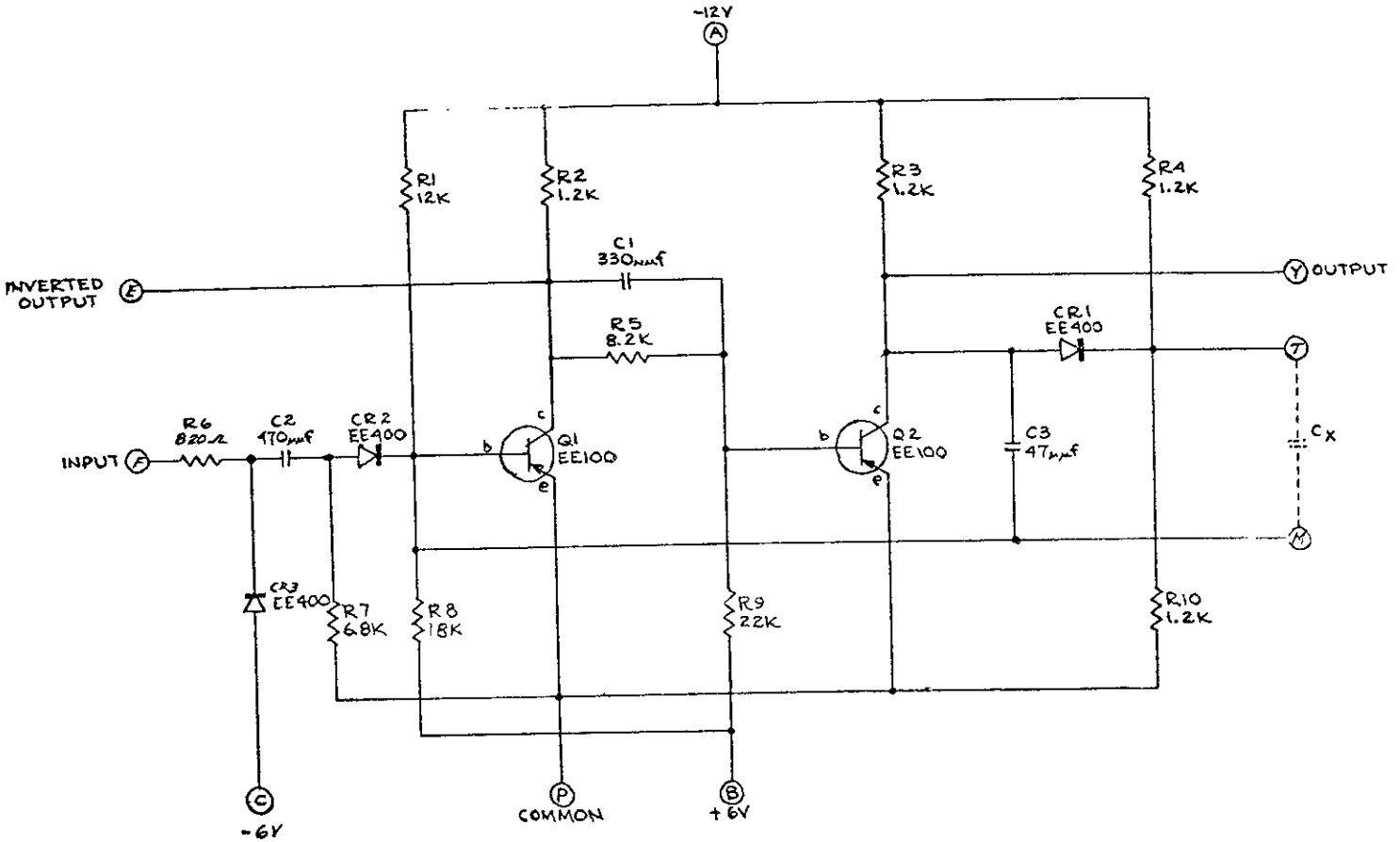


Counter Chassis "Time Delay Unit" - Bottom View



Logic Interconnection Diagram

LTR	REVISION	APVD
A	ECR # 2270	



SC-0215

Keywords :- (H) (J) (S)

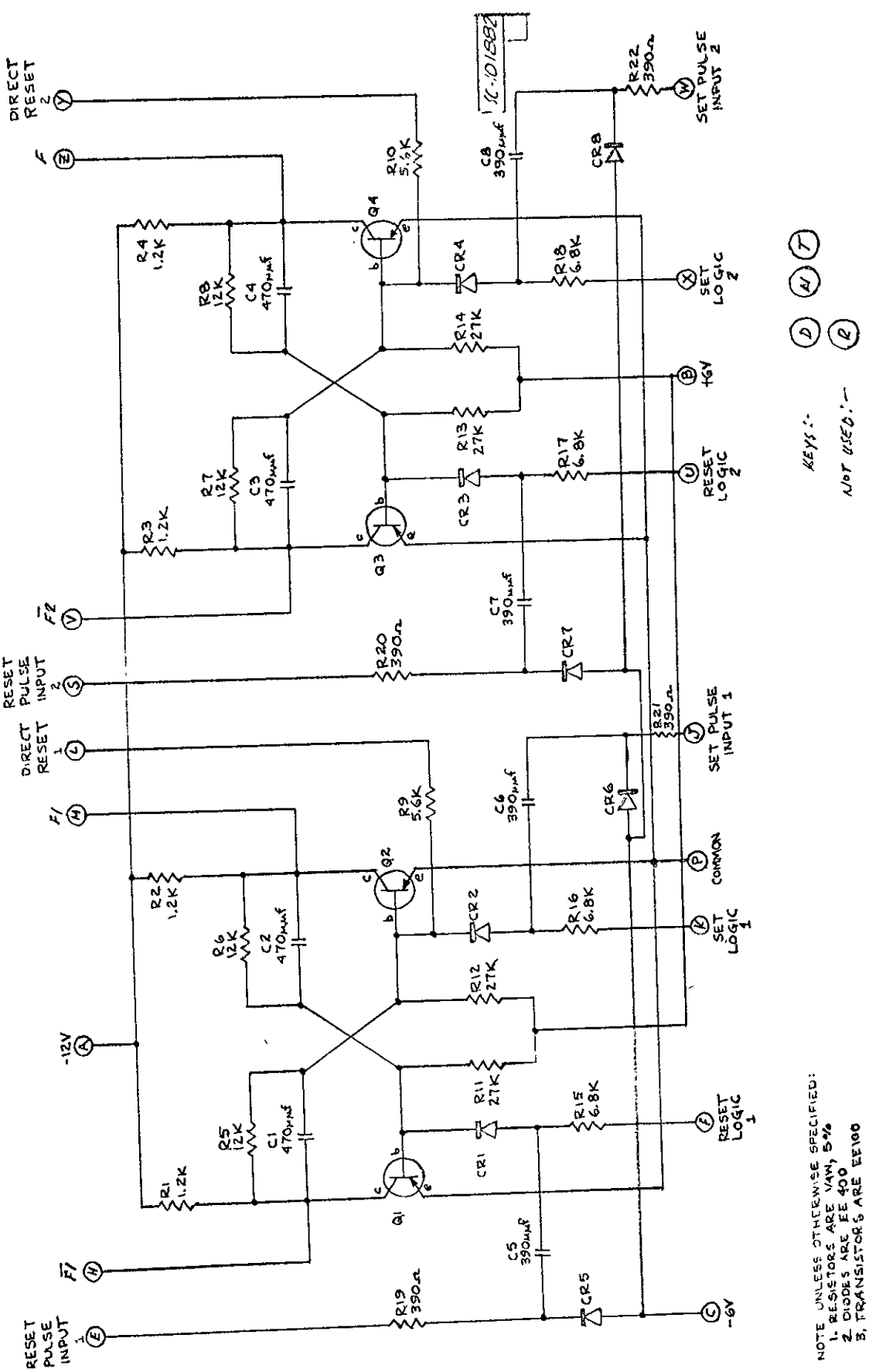
Not Used :- (D) (K) (L) (N) (R) (U) (V) (W) (X) (Z)

NOTE: UNLESS OTHERWISE SPECIFIED:
1. RESISTORS ARE 1/4W, 5%.

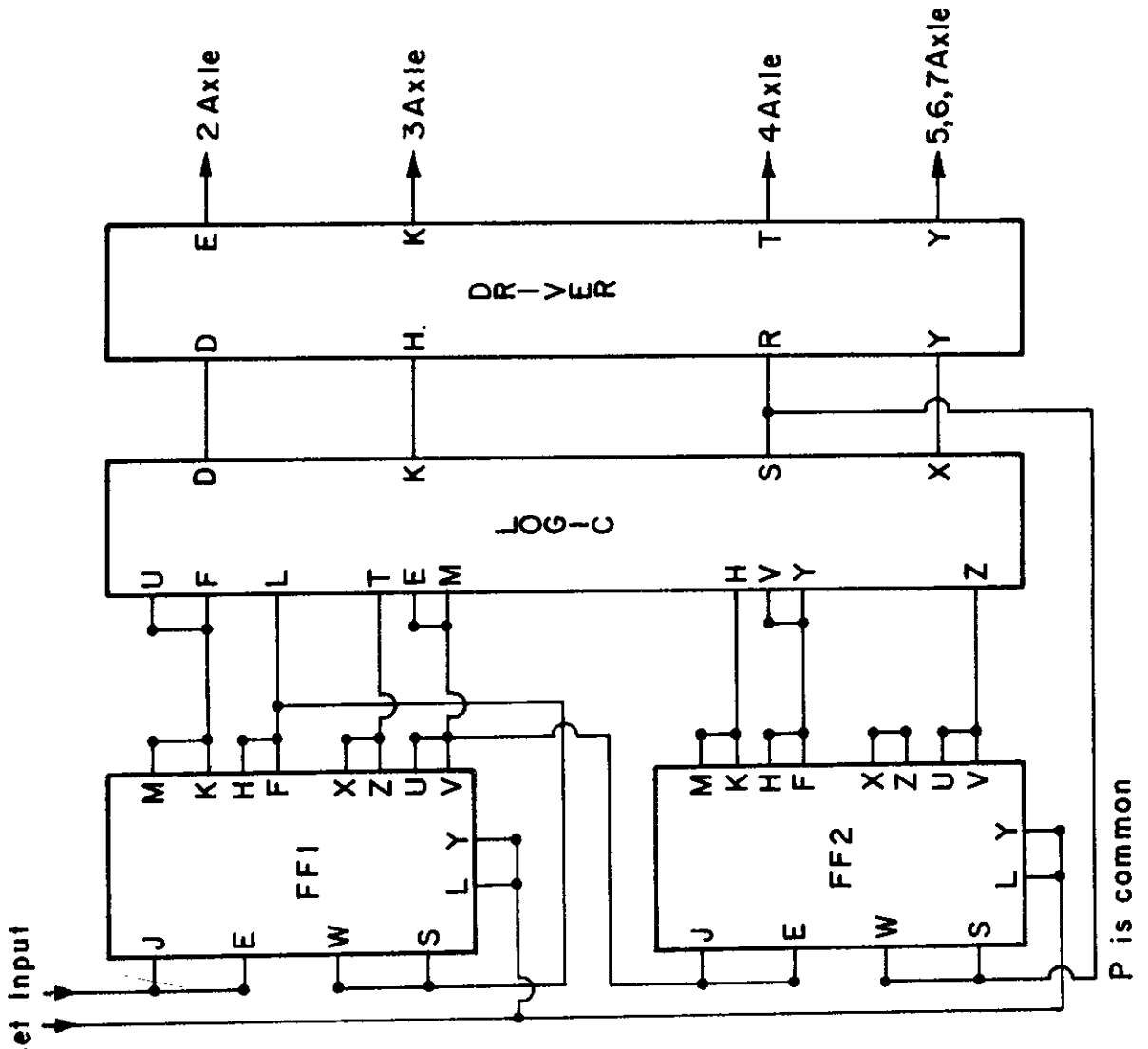
ONE SHOT	G-306
E. ROBERTSON 4-13-72	
D. Baggio 4-19-72	ENGINEERED ELECTRONICS CO. SANTA ANA, CALIFORNIA
	SC-102194A

One Shot Diagram

EXHIBIT 11



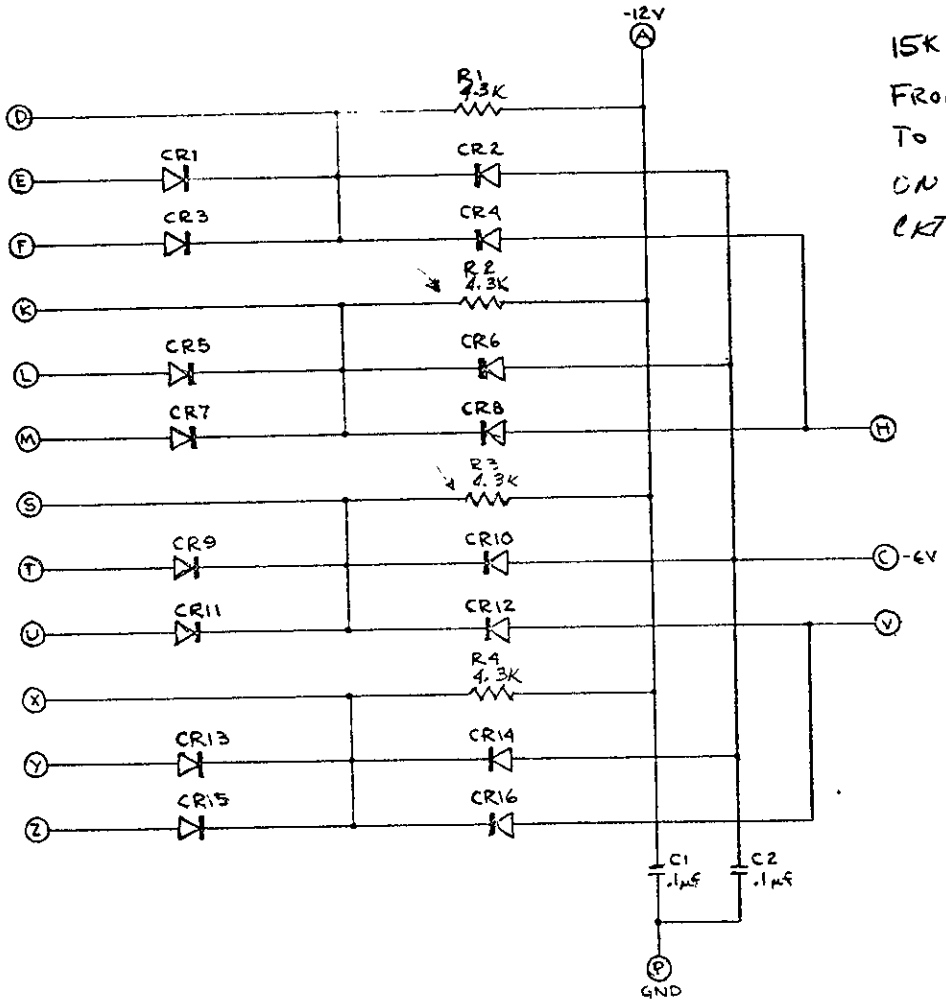
Dual Gated Flip-Flop



Flip-Flop Sequence

No. of Actuations	RS	1	2	3	4	5	6	7	8
	I	O	I	O	I	O	I	O	I
	O	I	O	I	O	I	O	I	O
	I	I	O	O	I	I	O	O	I
	O	O	I	I	O	O	I	I	O
	I	I	I	I	O	O	O	O	I
	O	O	O	O	I	I	I	I	O
	I	I	I	I	I	O	O	O	O
	O	O	O	O	O	I	I	I	I

Wiring Diagram with Flip-Flop Sequence



15K RESISTOR
FROM PIN K
TO PIN A
ON MODIFIED COUNTER
CKT

SC-102688

NOTE: UNLESS OTHERWISE SPECIFIED:
1. RESISTORS ARE 1/4W, 5%
2. DIODES ARE EE 400

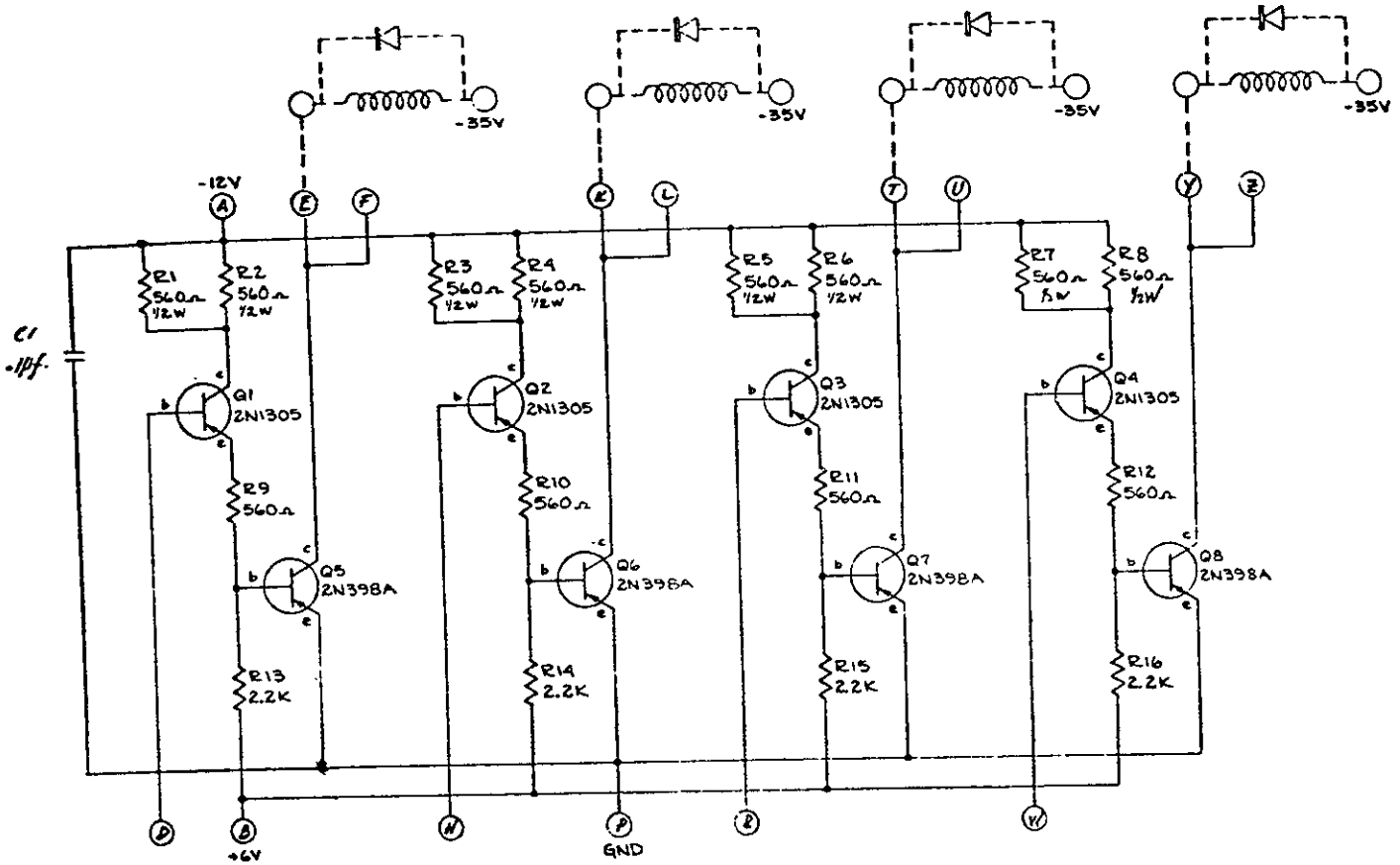
KEYS:- (B) (R) (W)

NOT USED:- (J) (N)

UNIVERSAL LOGIC A		G-701
E. ROBERTSON	2-6-62	
	2-6-62	
	2/6	SANTA ANA, CALIFORNIA
		SC-102688

Universal Logic Diagram

EXHIBIT 14



SC-102444

KEYS :- J M S

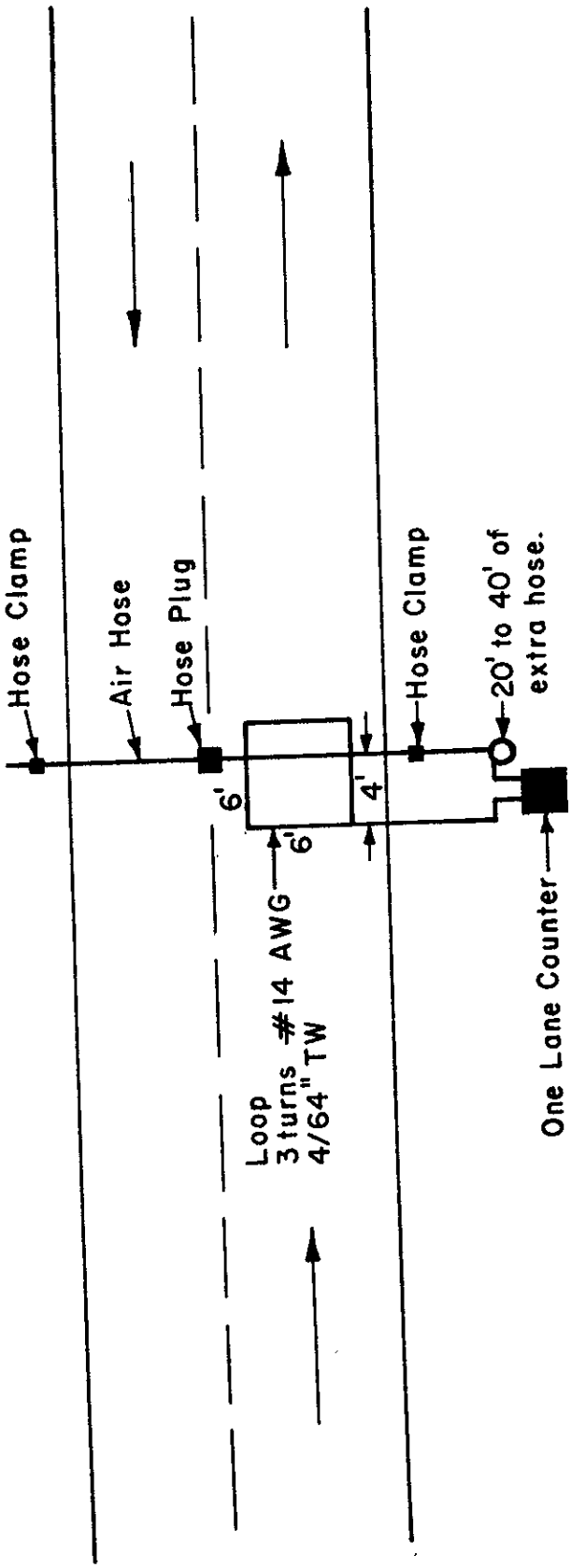
NOT USED :- C N V X

NOTE: UNLESS OTHERWISE SPECIFIED:
1. RESISTORS ARE 1/4W, 5%.

MATERIAL			
TITLE: RELAY DRIVER			G-502
SCALE	DRAWN BY: E. ROBERTSON	DATE: 5-22-62	PROJECT
TOLERANCE UNLESS OTHERWISE SPECIFIED: DECIMAL ± .XX, FRACTIONS ± 1/64, ANGULAR ± 5°, CAPACITY SEE SPEC, RESISTANCE 5%	CHECKED BY: [illegible] 6-22-62		ELECTRO ELECTRONICS Company SANTA ANA, CALIFORNIA
	APPROVED		DWG. NO. SC-102444
	APPROVED: [illegible] 7/12/62		

Relay Driver Diagram

EXHIBIT 15



Count Station Installation